PART I - ADMINISTRATIVE

Section 1. General administrative information

Title of project

Evaluate Factors Limiting Columbia River Gorge Chum Salmon Populations

BPA project number: 20120
Contract renewal date (mm/yyyy): ☐ **Multiple actions?**

Business name of agency, institution or organization requesting funding
U. S. Fish and Wildlife Service

Business acronym (if appropriate) USFWS

Proposal contact person or principal investigator:

Name	Travis Coley
Mailing Address	9317 Highway 99, Suite I
City, ST Zip	Vancouver, WA 98665
Phone	(360) 696-7605
Fax	(360) 696-7968
Email address	Travis_Coley@fws.gov

NPPC Program Measure Number(s) which this project addresses
2.2A, 3.3A.2, 3.3B, 4.1, 4.1A.1, 4.1A.2, 4.1A.3, 4.1A.5, 5.9A, 6.1A, 7.1, 7.1A, 7.1C,7.1D, 7.5D.1, 7.6, 7.6A.2, 7.6B.3, 7.8G

FWS/NMFS Biological Opinion Number(s) which this project addresses

Other planning document references
Washington Department of Fish and Wildlife- Wild Salmonid Policy

Short description
Evaluate factors limiting chum salmon production, spawning group relationships, population dynamics, biological and ecological characteristics, and implement habitat enhancement in tributaries below Bonneville Dam.

Target species
Chum Salmon

Section 2. Sorting and evaluation

Subbasin
Lower Columbia

Evaluation Process Sort

CBFWA caucus	Special evaluation process	ISRP project type

Mark one or more caucus	If your project fits either of these processes, mark one or both	Mark one or more categories
☒ Anadromous fish ☐ Resident fish ☐ Wildlife	☐ Multi-year (milestone-based evaluation) ☐ Watershed project evaluation	☐ Watershed councils/model watersheds ☐ Information dissemination ☐ Operation & maintenance ☐ New construction ☒ Research & monitoring ☒ Implementation & management ☐ Wildlife habitat acquisitions

Section 3. Relationships to other Bonneville projects

Umbrella / sub-proposal relationships. List umbrella project first.

Project #	Project title/description

Other dependent or critically-related projects

Project #	Project title/description	Nature of relationship
99003	Evaluate spawning of salmon just below the four lowermost Columbia dams	This project is currently evaluating the effects of hydropower operations on mainstem spawning chum salmon below Bonneville Dam, and our proposed project will establish what relationship exists between those fish and chum spawning in two adjacent streams.

Section 4. Objectives, tasks and schedules

Past accomplishments

Year	Accomplishment	Met biological objectives?

Objectives and tasks

Obj 1,2,3	Objective	Task a,b,c	Task
1	Evaluate the relationship between mainstem and tributary spawning chum salmon.	a	Capture and tag 20 individuals from each location (total, n=60) yearly and evaluate movements between locations by radio-telemetry.

		b	Evaluate homing fidelity by uniquely marking smolts in Hamilton and Hardy Creeks and monitoring where they return to spawn.
2	Evaluate factors limiting chum production in Hamilton and Hardy Creeks	a	Manufacture, install and operate weirs in Hardy and Hamilton Creeks to capture adult chum for radio-tagging, to measure biological characteristics, and to determine adult spawning escapement.
		b	Validate spawning ground counts by comparing weir counts with spawning ground counts
		c	Trap outmigrating chum smolts by fyke net in Hardy and Hamilton Creeks and evaluate weekly population abundance by mark-recapture techniques
		d	Monitor intragravel and ambient water quality parameters during incubation by withdrawing water samples from within redds and the water column, and measuring water chemistry parameters.
		e	Evaluate substrate composition in chum spawning areas by removing sediment cores with a McNeil sampler.
		f	Measure discharge with current meters, ultrasonic doppler current profilers, or a combination of both; install staff gauges; and establish stage-discharge relationships.
3	Enhance and restore chum salmon production both in Hamilton and Hardy Creeks, and in nearby tributaries.	a	Construct a spawning channel adjacent to Hardy Creek on Pierce National Wildlife Refuge.
		b	Monitor and evaluate chum escapement and smolt production from the newly constructed spawning channel.
		c	Collect chum salmon from Hardy and Hamilton Creek to re-establish chum populations in streams with suitable chum habitat but no current chum populations.

Objective schedules and costs

Obj #	Start date mm/yyyy	End date mm/yyyy	Measureable biological objective(s)	Milestone	FY2000 Cost %
1	11/1999	12/2001	Determination if three groups of chum spawning in close proximity are separate populations		19.10%
2	11/1999	5/2004	Determination of factors limiting chum production in Hamilton and Hardy Creeks; also migration timing, population abundance, and ecological and biological		33.71%

			characteristics of these groups of chum.		
3	3/2000	5/2004	Increased runs of chum in existing habitat, and restarted populations in historic habitats		47.19%
				Total	100.00%

Schedule constraints
ESA and other state and federal permits required for spawning channel construction

Completion date
2004

Section 5. Budget

FY99 project budget (BPA obligated): $0

FY2000 budget by line item

Item	Note	% of total	FY2000
Personnel	70% GS-09 Project leader, 2- 50% GS-07 Biologists, 80% GS-06 Technician	%40	76,300
Fringe benefits	28% for all personnel	%11	21,400
Supplies, materials, non-expendable property	Fyke nets, beach seines, radio-tags, MS-222, marking supplies, misc. equipment.	%10	18,800
Operations & maintenance	Vehicle and boat rental.	%4	7,600
Capital acquisitions or improvements (e.g. land, buildings, major equip.)	Weir construction.	%5	10,000
NEPA costs		%1	1,500
Construction-related support	Spawning channel.	%8	15,000
PIT tags	# of tags: 0	%0	
Travel	Professional and coordination meeting attendance.	%1	2,000
Indirect costs	23%	%18	34,753
Subcontractor	Biological Resources Division- Columbia River Research Laboratory	%1	2,500
Other		%0	
		TOTAL BPA FY2000 BUDGET REQUEST	$189,853

Cost sharing

Organization	Item or service provided	% total project cost (incl. BPA)	Amount ($)
USFWS	Supervisory biologist	%4	13,200
USFWS	Office space	%1	4,800

USFWS	Heavy equipment and operators for construction of spawning channel	%3	10,000
Burlington Northern Santa Fe Railroad	Providing materials and personnel for spawning channel construction	%5	15,000
Biological Resources Division- Columbia River Research Lab	Radio-telemetry receivers	%10	32,000
Interfluve, Inc.	Engineering and design of spawning channel	%2	6000
USFWS	Engineering and design of spawning channel	%10	32000
USFWS	Materials for spawning channel stabilization and vegetation	%3	10000
Wolftree, Inc.	Channel construction	%3	10000
		Total project cost (including BPA portion)	$322,853

Outyear costs

	FY2001	FY02	FY03	FY04
Total budget	$154,013	$157,311	$82,902	$87,453

Section 6. References

Watershed?	Reference
☐	Bailey, N. T. J. 1951. On estimating the size of mobile populations from recapture data. Biometrika 38:293-306.
☐	Bonnell, R.G. 1991. Construction, operation, and evaluation of groundwater-fed side channnels for chum salmon in British Columbia. American Fisheries Society Symposium 10:109-124.
☐	Columbia Basin Fish and Wildlife Authority. 1991. Integrated system plan for salmon and steelhead production in the Columbia River basin. Columbia Basin Sytem Planning 90-12.
☐	Cowan, L. 1991. Physical characteristics and intragravel survival of chum salmon in developed and natural groundwater channels in Washington. American Fisheries Society Symposium 10:109-124.
☐	Davis, S.K., J.L. Congleton, and R.W. Tyler. 1980. Modified fyke net for the capture and retention of salmon smolts in large rivers. Progressive Fish Culturist 42(4): 235-237.
☐	Efron, B. and R. Tibshirani. 1986. Bootstrap methods for standard errors, confidence intervals, and other measures of statistical accuracy. Statistical Science 1:54-77.
☐	
☐	Gordon, N.D., T.A. McMahon, and B.L. Finlayson. 1992. Stream hydrology: an introduction for ecologists. Wiley, New York.
☐	Guy, C.S., H.L. Blankenship, and Larry A. Nielsen. 1996. Tagging and marking. Pages 353-383 in B.R. Murphy and D.W. Wills, editors. Fisheries Techniques, 2nd edition. American Fisheries Society, Bethesda, Maryland.
☐	Johnson, O.W., W.S. Grant, R.G. Cope, K. Neely, F.W. Waknitz, and R.S. Waples. 1997. Status review of chum salmon from Washington, Oregon, and California. U.S. Department of Commerce, NOAA Technical Memo. NMFS-NWFSC-32, 280 pp.
☐	Maret, T.R., T.A. Burton, G.W. Harvey, and W.H. Clark. 1993. Field testing of new monitoring protocols to assess brouwn trout spawning habitat in an Idaho stream. North American Journal of Fisheries Management 13:567-580.
☐	Murphy, M.L., J.F. Thedinga, and J.J. Pella. Bootstrap confidence intervals for trap-efficiency estimates of migrating fish. U.S. Department of Commerce, National Marine

	Fisheries Service, Alaska Fisheries Science Center, Juneau, Alaska.
☐	NMFS (National Marine Fisheries Service). 1998. Endangered and threatened species; proposed threatened status and designated critical habitat for Hood Canal summer-run chum salmon and Columbia River chum salmon. Federal Register 11774.
☐	Nehlsen, W., J.E. Williams, and J.A. Lichatowich. 1991. Pacific salmon at the crossroads: stocks at risk from California, Oregon, Idaho, and Washington. Fisheries (Bethesda) 16(2):4-21.
☐	Oregon Department of Fish and Wildlife and Washington Department of Fish and Wildlife. 1995. Status report of Columbia River fish runs and fisheries, 1938-1994. Joint Columbia River Management Staff. Clackamas, Oregon/Battle Ground, Washington. 291 pp
☐	Platts, W.S., W.F. Megahan, and G.W. Minshall. 1983. Methods for evaluating stream, riparian, and biotic conditions. Gen. Tech. Rep. INT-138. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station.
☐	Schroeder, R.K. 1996. A review of capture techniques for adult anadromous salmonids. Oregon Department of Fish and Wildlife Information Report 96-5.
☐	Thedinga, J.F., S.W. Johnson, K.V. Koski, J.M. Lorenz, and M.L. Murphy. 1993. Potential effects of flooding from Russell Fiord on salmonids and habitat in the Situk River, Alaska. U.S. Department of Commerce, National Marine Fisheries Service Rpt 93-01.
☐	Tobin, J.H. 1994. Construction and performance of a portable resistance board weir for counting migrating adult salmon in rivers. U.S. Fish and Wildlife Service, Kenai Fishery Resource Office, Alaska Fisheries Technical Report, Kenai, Alaska.
☐	WDF, WDW, and WWITT (Washington Departments of Fish and Wildlife and Western Washington Treaty Indian Tribes). 1993. 1992 Washington state salmon and steelhead stock inventory (SASSI). Washington Department of Fish and Wildlife. 212 pp. + appendices.
☐	Woods, P.F. 1980. Dissolved oxygen in intragravel water of three tributaries to Redwood Creek, Humboldt County, California. Water Resources Bulletin 16(1): 105-111.
☐	
☐	

PART II - NARRATIVE

Section 7. Abstract

Historically, chum salmon *(Oncorhynchus keta)* were abundant in the lower reaches of the Columbia River and may have spawned as far upstream as the Walla Walla River (over 500 Km inland) (Nehlsen et al. 1991). Columbia River chum salmon currently are primarily limited to the tributaries downstream of Bonneville Dam, with the majority of the fish (less than a thousand annually) spawning on the Washington side of the Columbia River. The known natural chum salmon production occurs in Grays River (Gorley Creek), Hamilton Creek, and Hardy Creek. Hardy and Hamilton Creeks are the farthest upstream chum populations at river mile (RM) 142 (Bonneville Dam is RM 145), separated by over 100 river miles from the Grays River. The collective group of Columbia River chum populations are proposed for listing as threatened under the Endangered Species Act by the National Marine Fisheries Service (NMFS). Whereas the chum spawning in Hamilton and Hardy Creeks, and nearby in the mainstem Columbia River, have been considered separate populations of a distinct stock, some evidence suggests that these groups of fish may be a single population. Understanding the relationship between the chum salmon spawning in these different locations is critical to their management, especially because of the influence of hydropower. Whereas the mainstem spawning group of chum are most directly affected by hydropower operations, Hamilton and Hardy Creeks can be affected as well. During high water events, backwater effects from the Columbia River causes deposition of sediment within the low gradient channel in the chum salmon spawning reach of Hardy Creek. Currently Hardy Creek experiences these detrimental backwater effects approximately every 2-5 years. Variable adult returns to Hamilton and Hardy Creeks suggest that some set of conditions limits returns to these creeks. This project will: 1) Examine factors limiting chum salmon production in Hamilton and Hardy Creeks; 2) Enhance and restore chum salmon production in Hamilton and Hardy

Creeks and near by tributaries; 3) Evaluate the relationship between mainstem Columbia River and tributary chum salmon populations.

Section 8. Project description

a. Technical and/or scientific background

Historically, chum salmon *(Oncorhynchus keta)* were abundant in the lower reaches of the Columbia River and may have spawned as far upstream as the Walla Walla River (over 500 Km inland) (Nehlsen et al. 1991). There is no historic run size information for the Columbia River. However, the maximum historical chum salmon landings were approximately 700,000 fish in 1928 (CBFWA 1990). By the 1950s, landings declined dramatically to only 10,000 fish (CBFWA 1990). Chum salmon currently are primarily limited to the tributaries downstream of Bonneville Dam, with the majority of the fish spawning on the Washington side of the Columbia River. Known natural chum salmon production occurs in the Grays River (Gorley Creek), Hamilton Creek, and Hardy Creek (CBFWA 1990, WDF et al. 1993). Hardy and Hamilton Creeks are the farthest upstream populations at river mile (RM) 142 (Bonneville Dam is RM 145), separated by over 100 river miles from the Grays River. Chum have irregularly been noticed spawning in the side-channel of the Columbia River between Hardy and Hamilton Creeks near Ives Island (Joe Hymer, Washington Department of Fish and Wildlife (WDFW), pers. comm.). The collective group of Columbia River chum populations are proposed for listing as threatened under the Endangered Species Act by the National Marine Fisheries Service (NMFS) (NMFS 1998).

Whereas the chum spawning in Hamilton and Hardy Creeks have been considered separate populations of a distinct stock, some evidence suggests that these groups of fish may be a single population. Current genetic information indicates that Hamilton Creek may differ genetically from from Hardy Creek in a given year but not if samples from different years are pooled (Larry LeClair, WDFW, pers. comm.). About 30% of male chum collected at a temporary weir in Hardy Creek showed signs of previous spawning, even though no spawning habitat exists below the weir in Hardy Creek (USFWS unpublished data), suggesting that some fish are moving between adjacent spawning locations. Since all three spawning locations are relatively small (total spawning length of the spawning area in Hardy Creek is <0.4 mi) and are within about 1 RM of each other, chum could very easily move between spawning locations. Not only do these conditions lend themselves to interchange of individuals between sites, but chum may be more likely to stray than other anadromous salmonids, especially in years when high escapements saturate available spawning habitat (summarized in Johnson et al. 1997).

Understanding the relationship between the chum salmon spawning in these different locations is critical to their management. For example, if the groups of fish spawning in these three locations are discrete populations (i.e., home to these specific locations with little straying), maintenance of flows over mainstem spawning areas becomes critical to the preservation of this population. If, however, these fish are part of a larger population and only spawn in the mainstem when spawning habitat is saturated in Hamilton or Hardy Creeks, or when access to Hamilton Creek is limited by low flows in the creek, then enhancement and restoration of tributary spawning areas may be useful to increasing the chum population as a way of protecting these fish from uncertain main river conditions.

Whereas the mainstem spawning group of chum are most directly affected by hydropower operations, Hamilton and Hardy Creeks can be affected as well. During high water events, backwater effects from the Columbia River causes deposition of sediment within the low gradient channel in the chum salmon spawning reach of Hardy Creek. This deposited sediment covers spawning gravel, thereby significantly reducing the available spawning habitat and smothering incubation eggs in redds. For example, in 1996, sediment deposition appears to have destroyed an entire year class of chum salmon in Hardy Creek (Ken Keller, WDFW, pers.com.). The duration of this backwater effect is greater because the natural hydrograph had been modified by mainstem Columbia River Dams, prolonging the backwater effect during flood control operations.

Currently Hardy Creek experiences these detrimental backwater effects approximately every 2-5 years. Between 100 and 400 chum salmon spawn in a small section of the channel (< 0.4 mi). Spawning channels are currently successfully mitigating for some chum salmon habitat losses at Hamilton and Gorely Creeks (CBFWA 1990). A similar channel is slated for construction, pending fund procurement, on Hardy Creek, potentially increasing chum spawning habitat by six fold. The proposed alignment for the new channel also locates the majority of the spawning at elevations rarely affected by the backwater effect and assures that these events will not cause major aggradation of suspended sediments on the new spawning habitat.

Variable adult returns to Hamilton and Hardy Creeks (CBFWA 1990, Hymer 1994, USFWS unpublished data) suggest that some set of conditions limits returns to creeks. Whereas these returns may relate to mainstem hydropower operations, other conditions within the stream may also be responsible for differential fry survival.

Evaluation of factors mentioned above will provide information that will improve management and preservation of this important stock of chum salmon. This project will: 1) Examine factors limiting chum salmon production in Hamilton and Hardy Creeks; 2) Enhance and restore chum salmon production in Hamilton and Hardy Creeks and nearby tributaries; 3) Evaluate the relationship between mainstem Columbia River and tributary chum salmon populations. Factors limiting chum salmon spawning in the mainstem are currently being examined by a WDFW, USFWS, and Oregon Department of Fish and Wildlife (ODFW) cooperative study. USFWS is currently conducting a watershed analysis of the Hardy Creek basin. Furthermore, this project will aid a WDFW effort to restore chum salmon to streams historically supporting chum by using Remote Streamside Incubators (RSI) to reintroduce chum.

b. Rationale and significance to Regional Programs

Specific Benefits to the NPPC's Fish and Wildlife Program

2.2A Support Native Species in Native Habitat

The Hardy/Hamilton Creek chum salmon stock has remained viable despite the system wide population crash of the mid-1950's (ODFW and WDFW 1995). This stock of fish is one of the few native, natural reproducing and genetically pure populations of salmon in the Columbia River Basin. The only other Columbia River chum stock is found in the Grays River, over 100 river miles downstream of the Hardy Creek/ Hamilton stock, and are genetically distinct . Therefore, maintaining this population is critical to maintaining chum salmon in the Columbia River basin.

2.2E Columbia River Basin Reservoir Operation and Accounting Procedure

The Hardy Creek population of chum is greatly affected by the release of water due to the operation of Bonneville Dam. When large amounts of water are released from the dam, the tailrace elevation increases dramatically. When this occurs, depending on the total river discharge, tidal influence and other factors, the spawning areas of chum salmon in Hardy Creek can potentially become inundated to the point of no measurable flow (USFWS, unpublished data) and are then less desirable for spawning and egg incubation. In contrast, in periods of extremely low flow, the low tailrace elevation can also drop the level of the mouth of Hardy Creek to few centimeters deep limiting access to the spawning areas (USFWS, unpublished data).

3.2 Monitoring and Evaluation

The critical nature of this population requires monitoring so that both effects of hydropower and of restoration actions can be evaluated. Construction of a spawning channel off of Hardy Creek, which has been effective in Hamilton Creek and other places (Bonnell 1991, Cowan 1991), requires M& E so that it can be adaptively managed to increase the production of naturally spawning chum salmon in this stock and in the Columbia River.

3.3 Endangered Species Act Monitoring

Chum salmon are currently proposed for listing as threatened under the Endangered Species Act (ESA). Monitoring and evaluation of these populations will be a primary duty of this project.

4.1 Salmon and Steelhead Goal: Double Salmon and Steelhead Runs Without Loss of Biological Diversity

The construction of a spawning channel on Pierce NWR could significantly increase the current spawning area for chum salmon in the Hardy Creek drainage. The naturally spawning fish using the spawning channel would most likely be sustained over the long term and maintain a higher level of genetic diversity as opposed to artificial supplementation or other methods.

4.3C Population Monitoring

This stock of chum, being one of two remaining stocks of chum in the Columbia River, should be the indicator population for the species in this area and thus should be the focus of more intensive monitoring and enhancement.

7.1A Evaluation of Carrying Capacity

This study will determine factors limiting salmon production in Hardy and Hamilton Creeks and will increase the potential spawning habitat by construction of groundwater spawning channels near Hardy Creek. Knowledge of such factors will facilitate chum salmon recovery and enhancement not just in Hardy Creek, but also in adjacent tributaries where chum salmon have been extirpated.

7.1C Collection of Population Status, Life History and Other Data on Wild and Naturally Spawning Populations.

Baseline information that will improve the management of this wild stock will be collected and analyzed. Such information will also improve management of other chum salmon stocks.

7.1D Wild and Naturally Spawning Policy

This stock of chum salmon is one of the last wild and naturally spawning populations of any salmonid species, not influenced by artificial production, in the Columbia River basin. Therefore, the conservation and management of this stock should be given top priority.

7.5D Columbia River Chum Salmon

This project will mitigate for chum salmon losses to hydropower development, and will improve management of, and enhance, a stock currently affected by hydropower operations.

7.6 Habitat…

This project will preserve, enhance productivity of, and restore habitat critical to chum salmon, and will provide knowledge for improved management of habitat. USFWS is currently conducting a watershed analysis of Hardy Creek.

c. Relationships to other projects

This project complements work currently underway by ODFW, WDFW, and USFWS (BPA Project 99-003-01) on the group of chum and fall chinook spawning on the mainstem Columbia River near Ives Island, which seeks to evaluate habitat use, biological characteristics and limiting factors of these fish. We will coordinate our activities with this project so that no overlap occurs and information is shared. We will also collect and archive DNA samples from adult fish in accordance with WDFW genetics lab protocols, and make these available to that lab. We will also capture, aid in fish transfer and spawning, and coordinate in all other possible ways with WDFW to aid the restoration of chum runs in other streams by Remote Streamside Incubators, etc.

d. Project history (for ongoing projects)

This is a new project.

e. Proposal objectives

1. Evaluate the relationship between mainstem and tributary spawning chum salmon.
   Hypotheses Tested (H_o):

   a. Mainstem and tributary spawning chum salmon represent a single spawning population of chum salmon.

   b. Mainstem and tributary adult chum salmon exhibit strong homing behavior and fidelity to natal streams or spawning areas.

   c. Migrational behaviour of male and female chum salmon on the spawning grounds is identical.

   Assumptions:

   d. Tags in chum salmon smolts will persist and be readable in returning adults.

   e. Gastric implant radio telemetry tags will persist in adult chum salmon.

2. Evaluate factors limiting chum production in Hamilton and Hardy Creeks.

   a. Smolt production is independent of physical factors in Hardy and Hamilton Creeks (spawning substrate composition, ambient and intragravel water quality parameters, discharge, etc.).

   b. Adult chum salmon return after four years at sea and escapement is consistent from year to year.

   c. Biological characteristics of adult chum salmon are equivalent inter-sexually.

   Assumptions:

   d. Chum salmon smolts are caught in a floating fyke net in numbers sufficient to conduct valid statistical analysis for smolt production and smolt to adult survival estimates.

   e. A weir will not affect emigration or select for differentiating characteristics of adult chum salmon into Hardy and Hamilton creeks.

   f. Stream morphology will remain stable enabling a stage discharge relationship and staff gage to be established for multiple year use.

3. Enhance and restore chum salmon production both in Hamilton and Hardy Creeks, and in nearby tributaries.

a. Chum salmon will spawn in a man made channel and populations will be enhanced with the increased spawning area provided.

b. Chum salmon will not re-establish populations in locations where they have been extirpated.

Assumptions:

c. A man made spawning channel will not decrease the egg to smolt survival ratio.

f. Methods

Evaluate the relationship between mainstem and tributary spawning chum salmon:

For the first three years of this study, 10 male and 10 female chum (total, n=60 per year) from each location will be fitted with an Advance Telemetry Systems (ATS) gastric implant, 148-152Mhz, coded, radio telemetry tag. Upon release, the fish will be tracked using LOTEK telemetry receivers at fixed sites near the mouths of Hamilton and Hardy Creeks, near the spawning areas of Hamilton and Hardy Creeks, and in the Ives Island complex of the Columbia River where chum have been observed spawning. Technicians will also track fish using mobile gear in the Columbia River and in the uppermost reaches of Hamilton and Hardy creeks and mark locations of fish and redds using Rockwell GPS receivers. Mobile tracking will occur both day and night to monitor diurnal and nocturnal behavior differences.

Evaluate factors limiting chum production in Hamilton and Hardy Creeks:

Beginning in November and December of each year, returning adult chum salmon will be captured by either a resistance-board weir (Tobin 1994, Schroeder 1996) in Hardy Creek, a picket weir (Schroeder 1996) in Hamilton Creek and/or by seine (Scroeder 1996) in the two creeks and mainstem Columbia River. They will be anaesthetized using a solution of MS-222, biosampled (species, overall condition, sex, fork length, weight, and scales removed for aging), and marked with a T-bar anchor tag and an opercle punch as a secondary mark (Guy et al. 1996).

Hydrolab water quality probes (Hydrolab Corporation, 12921 Burnet Road, Austin, TX 78727) will be used to measure ambient water quality parameters, including temperature, dissolved oxygen, turbidity, and conductivity, continuously at fixed sites in Hardy and Hamilton Creeks. Intragravel water quality will also be measured in redds and in nearby areas without redds by withdrawing water from the gravel at egg pocket depth using peristaltic pumps and dissolved oxygen monitoring probes (modified from Maret et al. 1993) to analyze factors influencing egg to fry survival. After fry swim-up is complete, spawning substrate compostion will be collected from the same redds from which water quality parameter were measure and analyzed using a McNeil sampler (Platts et al 1983). A stage-discharge relationship will be established for both Hamilton and Hardy Creeks by installing a staff gauge, surveying its associated cross-section to a bench-mark, and measuring mutliple discharges on the cross-section (Gordon et al. 1992).

Out-migrating juvenile salmon will be trapped in March, April, and May using floating fyke nets modified from Davis et al. (1980) deployed in Hardy Creek and in the Hamilton Creek spawning channel. Captured fish will be enumerated, identified by species, and measured for length. A weekly sub-sample of 200 fish will be tattooed and released upstream of the fyke nets to conduct mark-recaptured tests to determine weekly population estimates (Baily 1951, Thedinga et al. 1993). A subsample of marked fish will be held overnight to evaluate short-term mark retention and survival so that trap efficiency can be adjusted accordingly (Murphy et al. 1996). Variance will be determined by bootstrap analysis (Efron and Tibshirani 1986). Accuracy of this method depends on marked and unmarked chum having equal capture efficiency.

Data will be input into both a Global Information System (GIS) database and a personal computer based database (i.e. R-Base or Microsoft Access) to analyze fish movements in the study areas. All required statistical tests will be computed by the program SAS (SAS 1989).

Enhance and restore chum salmon production both in Hamilton and Hardy Creeks, and in nearby tributaries:

A spawning channel will be constructed on Pierce National Wildlife Refuge in a relic Hardy Creek channel that is infrequently flooded by backwater effects of the Columbia River (USFWS, unpublished data; Interfluve, unpublished data). This channel incorporates successful designs from Canada, Alaska, and Washington (i.e., Bonnell 1991, Cowan 1991).

Trapping operations conducted by this project will provide chum salmon to WDFW for use in their RSI project in an effort to re-establish chum in streams which no longer support this species (Donna Hale, WDFW, pers. comm.).

g. Facilities and equipment

USFWS staff members will be stationed at the Columbia River Fishery Program Office (CRFPO) in Vancouver, WA where there is existing office space for four field personnel, including two biologists and two technicians, and one management level biologist. Parking for GSA and Department of the Interior vehicles are available at the office. Warehouse and shop space is available in Hazel Dell, WA and on the Pierce National Wildlife Refuge (NWR) to be used for maintaining and storing equipment and miscellaneous supplies. Personnel from USGS will continue to be stationed at the Columbia River Research Lab (CRRL) in Cook, WA.

LOTEK telemetry receivers and antennae will be borrowed from the Biological Resource Division of USGS at the CRRL. Fixed site receivers will be established on the Pierce NWR and near Hamilton Creek in the vicinity of North Bonneville, Washington and mobile tracking units will be stored at the Columbia River FPO when not in use or transit. Radio tags in the range of 148-152Mhz will be procured through Advanced Telemetry Systems in Isanti, Minnesota.

One jet boat will be leased from the USFWS for a portion of the study to track radio-tagged fish, which may migrate and or spawn in the mainstem Columbia River. This boat is stored at the Ridgefield NWR in Ridgefield, Washington.

A resistance board weir (Tobin 1994) will be manufactured and installed in Hardy Creek on the Pierce NWR and a standard picket weir will be manufactured and installed in Hamilton Creek. Seines will be purchased and used to catch adult chum salmon in Hardy Creek, Hamilton Creek and the mainstem Columbia River and fyke nets will be purchased and placed in Hardy Creek as part of the out-migrant monitoring program.

Underwater video cameras will be purchased and placed in the weirs on Hardy and Hamilton Creeks and operated continuously during the adult migration to enumerate and identify fish species.

Hydrolabs will be provided by the USFWS and used to measure the chemical and physical parameters in the stream including conductivity, temperature and dissolved oxygen.

Miscellaneous equipment, including but not limited to GPS receivers, flow meters, cellular phones, personal computers, etc… will be provided by the USFWS and stored at the CRFPO.

h. Budget

The budget outlined for this proposal will cover a tremendous amount of significant work on the study of the freshwater life stages of Chum Salmon in the Lower Columbia River. The work will be performed by existing staff at the Columbia River Fisheries Program Office including supervision by a Fishery Biologist, GS-12 (funded by the USFWS), Field Crew Leader /Fishery Biologist, GS-09, two field crew Biologists, GS-07, and one Biological Technician, GS-06. A GS-05 technician from USGS CRRL will provide assistance in setup and takedown of equipment for the radio telemetry portion of the study.

The USFWS and a variety of other outside entities will contribute approximately 42 percent of the cost of the project through equipment, services and grants. A substantial amount of equipment to be used on the project will be provided by the USFWS including but not limited to GPS units, a floating fyke net, tagging equipment, riparian restoration supplies, heavy equipment, a substantial tract of land for the

spawning channel and stream flow measuring equipment. No new office or storage space would be required and each crewmember has a Y2K compliant personal computer for performing data entry and analysis. Equipment and services provided by other organizations include the use of radio-telemetry receivers through USGS-CRRL, a channel construction grant through Wolftree Inc., assistance in the construction and design of the spawning channel, Interfluve Inc., and assistance in accessing ground water sources, Burlington Northern-Santa Fe Railroad.

Cost saving measures to be implemented throughout the study include the installation of an underwater video camera at the resistance board weir and trap in Hardy and Hamilton Creeks. This will reduce the number of personnel needed to inspect the trap during the course of the study as well as in future years. USFWS personnel will perform construction of the weir in an effort to lower costs. Other measures include having used radio tags refurbished for the second year of the study at a cost of $50 a piece (rather than the new purchase price of $190) for a savings of nearly $10,000. In addition, the crew is stationed close enough to the study area where travel and per diem costs will be held to a minimum and supplementary training of crew members will not be necessary.

Section 9. Key personnel

Scott A. Barndt, Paul Ocker and Travis C. Coley are currently monitoring spawning habitat characteristics, juvenile outmigration abundance and timing, and adult spawning run sizes in Hardy Creek as part of a comprehensive watershed analysis of Hardy Creek. Mr. Coley is supervisory fish biologist and Mr. Barndt and Mr. Ocker are field supervisors for this project.

Resumes:

Name: Travis C. Coley
Present Position: U.S. Fish and Wildlife Service
Columbia River Fisheries Program Office
9317 N. E. Highway 99, Suite I
Vancouver, WA 98665

Education and Training:

Degree	Date	School
B.S. Fisheries Management	1976	Mississippi State University
M.S. Fisheries Resources	1979	University of Idaho

Experience:

1991-present Team leader, Habitat and Natural Production Team, Columbia River Fisheries Program Office

Supervises a staff of 12 biologists and technicians working primarily on habitat assessment, habitat restoration, and fish population assessment and monitoring. Has supervised chum salmon monitoring and watershed analysis of Hardy Creek on Pierce National Wildlife Refuge.

1986-1991 Assistant Project Leader of the Idaho Fisheries Resources Office, U. S. Fish and Wildlife Service, Ahsahka, Idaho.

1978-1986 Northwest and Alaska Fisheries Center, National Marine Fisheries Service, Hammond, OR

Pertinent Reports and Publications:

Muir, W.D. and T.C. Coley. 1996. Diet of yearling chinook salmon and feeding success during downstream migration in the Snake and Columbia Rivers. Northwest Science 70 (298-305).

Muir, W.D., A.E. Giorgi, and T.C. Coley. 1994. Behavioral and physiological changes in yearling chinook salmon during hatchery residence and downstream migration. Aquaculture 127(69-82).
McCabe, G.T., Jr., R.L. Emmett, T.C. Coley, and R.J. McConnell. 1988. Distribution, density, and size class structure of Dungeness crab in the river-dominated Columbia River estuary. Northwest Science 62(5):254-262.
Giorgi, A.E., G.A. Swan, W.S. Zaugg, T.C. Coley, and T.Y. Barila. 1988. Susceptibility of chinook salmon smolts to bypass systems at hydroelectric dams. North American Journal of Fisheries Management 8:25-29.
McCabe, G.T., Jr., R.L. Emmett, T.C. Coley, and R.J. McConnell. 1987. Effects of a river dominated estuary on the prevalence of *Crinonemertes errans*, an egg predator of the Dungeness crab, *Cancer magister*. Fishery Bulletin 85:140-142.

Paul A. Ocker – Field Crew Leader for proposed work

Current Position: Fishery Biologist Management, GS-09
Field Crew Supervisor

Education:

B.S.	Biological Sciences	1991	California Polytechnic State University
	Marine Biology	1988	University of Oregon at Charleston (OIMB)

Experience:

Associate Scientist 3, Robert Schlotterbeck Inc., Avila Beach, California, Biological Monitoring of Nuclear Facility, 1989
Fishery Biologist Technician, US Forest Service, Hebo, Oregon, Hankin-Reeves Stream Survey, 1990
Park Ranger – Resource Mgmt, National Park Service, Homestead, Florida, Water Quality and Sport Fisheries Program, 1991-92
Fishery Biologist – Research, National Marine Fisheries Service, Pasco, Washington, Radio Telemetry and PIT tag Studies, 1993-95
Fishery Biologist – Management, US Fish and Wildlife Service, Vancouver, Washington, Instream Flow Program Field Crew Leader, 1995-present

Current Assignment:

Over the past three years I have been the field crew leader for the US Fish and Wildlife Services sub-contract of BPA project 86-50, known as the White Sturgeon Project, and BPA project 99-003 the project dealing with fall chinook and chum salmon spawning downstream from Bonneville Dam. Both of these projects have involved conducting flow studies to determine optimum spawning flows for the designated species. I have also been involved with other flow studies and have assisted in various other projects ranging from stream rehabilitation and smolt trapping to wildlife issues.

Co-Authorships:-

Biological Evaluation of the Prototype Gatewell Lift-Tank System at Lower Granite Dam, 1994, NMFS
Survival Estimates for the Passage of Juvenile Salmonids through Snake RiverDams and Reservoirs, 1994 , NMFS
Relative Survival of Juvenile Chinook Salmon through Spillbays and the Tailrace at Lower Monumental Dam, 1995 , NMFS
Survival Estimates for the Passage of Juvenile Salmonids through Snake River Dams and

Reservoirs, 1995 , NMFS

Migrational Characteristics of Adult Spring, Summer and Fall Chinook Salmon Passing through Reservoirs and Dams of the Mid-Columbia River, 1995, NMFS

Juvenile radio-telemetry study at Ice Harbor Dam, 1995, NMFS

Effects of Mitigative Measures on Productivity of White Sturgeon Populations in the Columbia River Downstream from McNary Dam, and Determine Status and Habitat Requirements of White Sturgeon Populations in the Columbia and Snake Rivers Upstream from McNary Dam - BPA Annual Report - Section E – In Press, 1995, USFWS

Effects of Mitigative Measures on Productivity of White Sturgeon Populations in the Columbia River Downstream from McNary Dam, and Determine Status and Habitat Requirements of White Sturgeon Populations in the Columbia and Snake Rivers Upstream from McNary Dam - BPA Annual Report - Section E – To Press, 1996, USFWS

Scott A. Barndt - Field Crew Leader for proposed work

Current Position: Fishery Biologist Management, GS-07
Field Crew Supervisor

Education:

B.S. Fish and Wildlife Management	1994	Montana State University, Bozeman, Montana
M.S. Biology	1996	Montana State Univerisity, Bozeman, Montana

Experience:

Laboratory and field technician, USDA-Agriculture Research Service, Bozeman, Montana. Conducted lab and field studies on biocontrol of noxious weeds with insects. 1990-94.

Laboratory technician, Montana State University, Bozeman, Montana. Analyzed coyote food habits. 1993.

Graduate research assistant, Montana State University, Bozeman, Montana. Studied arctic grayling movements, habitat use, biological characteristics, and ecological relationships. 1994-96.

Graduate teaching assistant, Montana State University, Bozeman, Montana. Taught ichthyology and mammology laboratory courses. 1996.

Fisheries biologist, Management, US Fish and Wildlife Service, Vancouver, Washington. Conduct habitat assessment, habitat restoration, and fish population assessment and monitoring studies. 1997-present.

Current Assignment:

Over the last two years I have participated in over 13 studies and projects, including juvenile and adult salmonid trapping and tagging projects, habitat assessments, and habitat restorations. Most recently, I have been a crew leader for a watershed analysis of a small SW Washington drainage, for chum and coho salmon monitoring activities, and for lamprey identification, habitat use, and tagging studies.

Publications:

Barndt, S.A. 1996. Biology and status of the grayling in Sunnyslope Canal, Montana. M.S. thesis. Montana State University, Bozeman, Montana.

Barndt, S.A. and C.M. Kaya. Reproduction, growth, and winter habitat of Arctic grayling in an irrigation canal which flows only during spring and summer. *In preparation*.

Barndt, S.A., T.C. Coley, B. Ensign, and J. Taylor. Watershed analysis of Gibbons Creek, Washington. *In preparation.*

Section 10. Information/technology transfer

Results from this study will be published in peer-reviewed journals and annual reports. Specific products of this study will include: syntheses of life history-specific marking and trapping techniques; population specific age, growth and fecundity; migration timing and movement patterns; and ecological interactions of adult and juvenile chum, including spawning habitat selection and limiting factors. We expect to fully coordinate activities and methods, and present results through meetings with other CRB researchers.

Congratulations!